DOCUMENT RESUME

ED 171 243 **IR 007 237**

AUTHOR	Vasu, Ellen Storey; Palmer, Richard I.
TITLE	An Introduction to Research and the Computer: A Self-Instructional Package.
INSTITUTION	North Carolina Univ., Chapel Hill. Inst. for Research in Social Science.
REPORT NO	IRSS-1
PUB DATE	Dec 77
NOTE	43p.
AVAILABLE FROM	Institute for Research in Social Science, 133 Manning Hall, University of North Carolina, Chapel Hill, North Carolina 27514 ($2.50)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Classroom Materials; *Computer Programs; Individualized Instruction; Research Design; Research Methodology; *Research Skills; *Social Science Research

ABSTRACT

This self-instructional package includes learning objectives, definitions, exercises, and feedback for learning some basic concepts and skills involved in using computers for analyzing data and understanding basic research terminology. Learning activities are divided into four sections: research and research hypotheses; variables, cases, and measurements; data, codebooks, and missing values; and computer cards, fields, and coding sheets. The information is compatible with use of SAS or SPSS and is appropriate for individualized or classroom use. (Author/JVP)

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IRSS-

Paper No. 1

AN INTRODUCTION TO RESEARCH AND THE COMPUTER: A SELF-INSTRUCTIONAL PACKAGE

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and
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TECHNICAL PAPERS

Institute for Research in Social Science
University of North Carolina at Chapel Hill
December 1977

IR007237

International Standard Book Number: 0-89143-085-7
Library of Congress Catalog Card Number: 77-28538

Institute for Research in Social Science
University of North Carolina at Chapel Hill

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Printed in the United States of America.

Library of Congress Cataloging in Publication Data

Vasu, Ellen Storey, 1948-
An introduction to research and the computer.

(IRSS technical papers; paper no. 1)
Bibliography.
1. Social science research--Data processing--Problems, exercises, etc. I. Palmer, Richard I., 1948- joint author. II. Title. III. Series: University of North Carolina at Chapel Hill. Institute for Research in Social Science. IRSS technical papers; paper no. 1.
H62.V34 300'.1'83 77-28538
ISBN 0-89143-085-7

PREFACE

The design of this package stemmed from a need we have at the Institute for Research in Social Science to provide individuals with an introduction to research terminology and the conversion of data into a form appropriate for computer analysis. We have found that individuals attending our series of computer- and research-oriented short courses are heterogeneous with respect to the amount of exposure they have had to computer usage and research. We developed this self-instructional package to help new users master basic concepts in research and data so that they will be able to comprehend and retain more of the information presented in the short course sessions. The concepts and definitions presented in the first sections of the package are meant to serve only as an introduction to the terms of research methodology and levels of measurement. We hope that individuals engaged in the research process will pursue the topics further and have included selected references at the end of the package for this purpose. Since this material may also be used by faculty members teaching methodologically or statistically oriented courses, we suggest that the reader consult selected references for further readings and examples.

Data can be arrayed and entered into a computer for analysis in a variety of ways. Since this is an introductory self-instructional package, we have limited our presentation to one medium and one format. The specific medium for data entry that is discussed within this package is the keypunched computer card. The specific format presented is Fixed Variable Format. This package is appropriate for individuals with no previous exposure to research and/or computer usage. The rules outlined are compatible with the statistical programs SAS (Statistical Analysis System) and SPSS (Statistical Package for the Social Sciences), both of which are widely used on the UNC-CH campus and within the TUCC (Triangle Universities Computation Center) computing environment.

Ellen Storey Vasu
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Chapel Hill, North Carolina
December 1977

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TABLE OF CONTENTS

Preface iii

Introduction. 1

Section 1: Research and Research Hypotheses. 1

Section 2: Variables, Cases, and Measurement 6

Section 3: Data, Codebooks, and Missing Values 15

Section 4: Computer Cards, Fields, and Coding Sheets . . . 24

Selected References 37

INTRODUCTION

The following package has been designed to assist you in learning some basic concepts and skills involved in using computers for analyzing data. The main objectives of this instruction are that, when you have completed the package, you will be able to

1. give simple definitions of theory, research problem, hypothesis, research, research hypothesis, data, case, and variable,
2. choose from a number of hypotheses those which are valid research hypotheses, and if not, explain why not,
3. determine the level of measurement to be used with given variables,
4. determine from a given research hypothesis what variables it will be necessary to measure and at what level of measurement each should be measured,
5. make a codebook for a computer analysis of the data contained in a given questionnaire, and
6. fill out a coding sheet for the data that will subsequently be used in a computer run to analyze the data.

The package consists of four sections. Each section is prefaced by a list of learning objectives for that section in order to focus your attention on particular learning goals. At certain points you will be asked to work out a practice question. After you have answered the question, you will be given the correct answer, and you can check your understanding of the material to that point.

SECTION 1
Research and Research Hypotheses

Upon completion of this section the learner will be able to

1. give a simple definition of theory,
2. give a simple definition of research problem,
3. give a simple definition of a hypothesis,
4. give a simple definition of research,
5. give a simple definition of a research hypothesis, and
6. choose from a list of hypotheses those which are valid research hypotheses, and if not, explain why not.

One of the reasons the human species has survived is its ability, in fact, its thirst, to explain phenomena in the world, and by so doing, be able to predict their occurrence. This predictive capability has allowed man and woman to order and time their activities within a basically hostile natural environment, and to use its natural order to their own advantage. Often, in the interest of explanation and predictability of an event or phenomenon, humans formulated a coherent set of definitions and/or propositions presenting a systematic view of that event. In effect they were developing *theories*. Let us repeat that for you. *A theory is a coherent set of interrelated definitions and/or propositions, presenting a systematic view of an event in the interest of explaining and predicting that event.*

For example, let us assume that a particular caveman (we will use the masculine gender for simplicity) based on his own

careful observation has determined that on autumn days, when it is cold and the wind blows from the north, when he has rabbit stew for breakfast and then goes to any sheltered canyon and enters from the south, he will find plenty of game there. He has determined this from his own past experience. This is, in effect, a theory for finding game (also known as "game theory"). In the interest of being able to predict when and where he can find food (a rather vital concern in those days), the caveman has developed a set of interrelated propositions--autumn, cold, north wind, rabbit for breakfast, sheltered canyon, southern entry--which present a systematic view of a phenomenon: the presence of edible game.

Another caveman, after considerable thought, might question this theory that he has heard via the caveman grapevine. He might especially question the part of the theory that holds that having rabbit for breakfast has anything to do with finding game. The second caveman has presented himself with a *research problem*, that is, *a question that asks what relationship exists between two or more events*. In this circumstance the problem could be stated, "What effect does X_4 (rabbit breakfast) have on Y (finding game)?" Again, this is a question that asks what the relationship is between two phenomena.

The second caveman, either after some intuitive thought or from his own experience, might conjecture that if it is autumn, if it is a cold day, if the wind is blowing from the north, *if he has quail for breakfast*, and if he then goes to any sheltered canyon and enters from the south, he will find edible game there. What he has proposed is a *hypothesis*, which is a *conjectural statement about the relationship existing between two or more events*. A hypothesis is closely related to a research problem, the difference being that while a research problem asks a question about a relationship between two or more phenomena, a hypothesis is a *conjectural statement* about that relationship.

Hypotheses are usually in the "if-then" formula, which stated simply is "if X, then Y." In our example the formula might be "If X_1 (season = autumn) + X_2 (weather = cold) + X_3 (wind = from north) + X_4 (breakfast = quail) + X_5 (destination = sheltered canyon) + X_6 (entry = from south), then Y (edible game). If this conjecture turned out to be true, it would alter the original theory somewhat, as it would be evident that X_4 does not have to be rabbit but could vary at least to quail without affecting Y, the presence of game.

The process of testing the validity of caveman #2's hypothesis is called research. Scientific *research is a systematic, empirical, and controlled inquiry into a subject area aimed at both identifying relevant phenomena and specifying relationships existing among these phenomena*. Thus if caveman #2 made a careful, systematic, empirical, and controlled inquiry into the effect or lack of effect that varying breakfast food had on finding game, he would be able to draw some conclusions about the relationship between the two factors, especially if he could investigate situations in which the other phenomena (variables) remain constant (controlled).

Notice in our sample "game theory," all of the phenomena or events are readily measurable through careful observation. Time of year, weather, wind direction, topographical location, approach direction, and breakfast regimen are all concepts which can be determined fairly objectively. Some theories and hypotheses, however, contain concepts which are not so self-evident, not so measurable. In fact, some contain elements which are not measurable or capable of being objectively determined at all. A *research hypothesis is a hypothesis which contains all objectively measurable concepts or events*. Hypotheses which contain concepts that cannot be objectively measured or determined are not research hypotheses because they cannot be tested objectively, empirically, and systematically to determine their validity. In many cases seemingly abstract concepts, which would at first glance appear to be resistant to objective determination, can be made measurable. For instance, intelligence might be measured through one or more standardized tests or by school achievement (grades). There are also instruments designed to measure creativity in an objective way although researchers may disagree as to the definition of creativity.

However, there are many intangible concepts that simply do not lend themselves easily to measurement, such as "hope," "beauty," "sincerity," "love," and so forth. These are concepts which are subjective by their very nature. Value-laden concepts, such as "good," "bad," "evil," sinful," are also difficult to measure and have no real place in research hypotheses. The existence of such concepts in a research hypothesis makes the hypothesis impossible to test objectively.

One way to facilitate your understanding of all these definitions is to remember them in relationship to one another. Start with a *theory--a coherent set of*

interrelated definitions and/or propositions presenting a systematic view of an event in the interest of explaining and predicting that event. Then question the theory. This gives you a *research problem, a question that asks what relationship exists between two or more events.* Having asked that question, you become bold and make an unsupported contention concerning this relationship. This is your *hypothesis,* or *the conjectural statement about the relationship existing between two or more events.* You must then investigate whether or not your hypothesis is true. This is your research, or a *systematic, empirical, and controlled inquiry into a subject area aimed at both identifying relevant phenomena and specifying relationships that you have hypothesized to exist among these phenomena or events.* If your hypothesis lends itself to such an investigation by containing only *concepts or events which are objectively measurable,* it is a valid *research hypothesis.* It is in the investigation of the probability of the truth of the hypothesis (or hypotheses) that researchers utilize statistical analysis. Since this topic is beyond the scope of this package, we have provided references at the end of the package for you to examine. The exercise on the next page is designed to assist you in determining your mastery of the material. Try not to refer back to the package. The answers are on page 5.

EXERCISE 1

Define the following terms in one sentence:

1. theory

2. research problem

3. hypothesis

4. research

5. research hypothesis

6. Examine the next five hypotheses. Determine which are valid research hypotheses, and for those which are not, explain why not. Mark V for valid; I for invalid.

   A. If the temperature is 32°F, standing water will freeze.

   B. If one is left-handed, he or she will have good luck.

   C. If a person is red-headed, that person will be stubborn.

   D. Left-handed people are more creative than right-handed people.

   E. Blue-eyed people have better attitudes about life than brown-eyed people.

When you finish, compare your answers with those we have provided on the next page.

FEEDBACK

1. A theory is a *coherent set of interrelated definitions and/or propositions presenting a systematic view of an event in the interest of explaining and predicting that event.*
2. A research problem is a *question that asks what relationship exists between two or more events.*
3. A hypothesis is a *conjectural statement about the relationship existing between two or more events.*
4. Research is a *systematic, empirical, and controlled inquiry into a subject area aimed at both identifying relevant phenomena and specifying relationships existing among these phenomena or events.*
5. A research hypothesis is a *hypothesis which contains only concepts or events that are objectively measurable.*
6. A. V - This hypothesis contains measurable phenomena and a relationship which can be objectively tested.

   B. I - The concept of luck is difficult to measure. "Good" luck is even more difficult to define since this probably means different things to different people. It is essentially a value judgment.

   C. I. The concept "stubborn" is also difficult to measure or determine. It would be a questionable contention in many cases whether or not the condition existed and would be open to various interpretations.

   D. V - Both phenomena can be objectively measured. Some years ago the concept of creativity was more subjective, but there are now instruments designed to measure it. The statement can easily be expressed in the "if-then" formula, too: "If a person is left-handed, then that person will score higher on a creativity measurement test than a right-handed person."

   E. I - Highly questionable. With the value-laden adjective "better," the concept becomes one not at all conducive to objective empirical research. "Attitudes," though not obviously objective, can be measured through attitude scales and instruments.

If you answered the questions more or less correctly, then you are ready to go on. If you missed any, you may want to go back over the section involved with that material until you understand where you made your mistake.

Once you have determined a valid research hypothesis, you are ready to begin your research, the results of which will, you hope, support your hypothesis. For information that will facilitate this research process, continue on to Section 2.

SECTION 2

Variables, Cases, and Measurement

Upon completion of this section the learner will be able to

1. define *case*,
2. define *variable*,
3. determine from a list of variables the *level of measurement* to be used in measuring each, and
4. determine from a given hypothesis the variables you need to measure and at what level they should be measured.

In order to make a systematic, controlled, empirical investigation of a hypothesis, that is, research, we have to be able to make measurements on the concepts or elements involved in the hypothesis as they occur over a number of occasions. The caveman made some observations concerning several characteristics of his hunting trips. He arrived at a theory when he noticed that a certain combination of these characteristics seemed to remain the same when he had successful hunts. In other words, the various characteristics he observed (which could and did change from hunt to hunt) were always the same in each *successful* hunt: season--autumn, weather --cold, wind--from north, and so forth. In a simplistic way he was taking measurements when he observed these characteristics and mentally recorded their nature for each hunting trip. He was measuring the various characteristics of each of a number of hunting trips.

CASE

In scientific research we call *the individual units whose characteristics we are measuring cases*. "Cases" might be individual people, states, countries, animals, organizations, test trials, or (as for the caveman) hunting trips. One hunting trip would represent one *case* in the caveman's study.

VARIABLE

The actual characteristics which we measure for each case in our research may be different (in fact, often are) from one case to another. For instance, in the example of the caveman the wind *could* have been blowing from the south, the west, the northeast, the southwest, and so forth, for any given hunting trip. In fact, we could assume that on one or more of his hunting trips the wind was indeed coming from these directions. Characteristics such as wind direction that we want to measure as they occur in a set of cases are called *variables* for the obvious reason that they may vary from case to case. Let's go over that again. A *variable is a characteristic associated with a set of cases which we would like to measure for each case.* Some examples of variables might be age, sex, height, rank in high school class, vote in the 1976 Presidential election (if our cases were people); or wind direction, season, temperature (if our cases were hunting trips).

LEVEL OF MEASUREMENT

For a particular case, the process of assigning values to the characteristics, or variables, in which we are interested is called measurement. When we assign a number to a variable to describe it as it occurs in a particular case, we need to be sure that we know exactly what that number means within the context of our study of that particular variable. Traditionally,

we assign numerical values to variables according to one of four different types of measurement systems called *levels of measurement*. A *level of measurement is a system of assigning numerical values to variables*. The four traditional levels of measurement are called *nominal*, *ordinal*, *interval*, and *ratio*.

Nominal Level of Measurement

The *nominal level of measurement* is being used when we assign a number for a variable as it occurs in a specific case solely as a name by which that particular variable value will be identified throughout a given study. The number assigned means nothing in terms of rank, quantity, and so forth. It is only a name, an identifier. For instance, we can conceive of categorizing the variable "season" in the caveman's study into four categories: spring, summer, autumn, winter. If we were to assign nominal values to these categories, we could assign the number (1) for spring, (2) for summer, (3) for autumn, (4) for winter. For each hunting trip (or case) observed, we then could assign a numerical value for the variable "season" solely as an identifier. We must then record a key of how we are assigning nominal values so that others using our study will be able to determine the exact way in which we are assigning numbers to the various categories of the variable. For this example the key might look like this:

Season		Numerical Code
Spring	-	1
Summer	-	2
Autumn	-	3
Winter	-	4

This key will eventually be placed in a codebook that will be explained later. For now it is important that you remember that it is necessary to construct such a key for nominal levels of measurement. With such a key our data might look like this:

Case # (hunting trip)	Variable #1 (season)
1	3
2	4
3	2
4	3

We then know that for Case #1 the variable "season" was autumn; for Case #2 it was winter, and so forth.

We could theoretically assign any number for the different categories of a variable since their numerical size has no meaning; for example, 52 for summer, 12 for autumn, 75 for spring, 15 for winter, but we must assign the same number to each case in which the corresponding variable value occurs throughout the study.

The exercise on the next page gives data for a study of 6 cases measuring the variable "religion." Construct a key and assign nominal values for the variable to each case.

EXERCISE 2

Develop a key, as we did for the variable season, and assign the numerical values to the cases below.

KEY

Religion	Numerical Code
Catholic	_____
Protestant	_____
Jewish	_____
Other	_____

Case	"Religion" Variable	Nominal Value
Bob	Catholic	_____
Tracy	Protestant	_____
Felix	Jewish	_____
Mort	Protestant	_____
Natasha	Moslem	_____
Mario	Catholic	_____

When you finish, turn to the next page for feedback.

FEEDBACK

One possible key might be

Religion	Numerical Code
Protestant	1
Catholic	2
Jewish	3
Other	4

and we could assign values in each case accordingly.

Ordinal Level of Measurement

At the *ordinal level of measurement* we assign a numerical value to a variable in a specific case as a reflection of where that particular case ranks with respect to the other cases in the study. There is no unit of measurement, only a ranking among cases. For example, we could rank six individuals with respect to the variable "weight." The heaviest person (case) would be assigned a rank of 1 and, therefore, the number "1" for the value of the variable "weight." The lightest person would be assigned the number "6" as the value for the variable "weight." Here again, however, we need to make a brief key to remind us which way the rankings go. For example:

Weight	Numerical Code
Heaviest	1
Lightest	6

If the following were weights we had taken from scales:

Case	Weight in Lbs.
Bob	220
Tracy	130
Felix	179
Mort	178
Natasha	115
Mario	185

then we would assign ordinal values like this:

Case	Weight in Lbs.	Numerical Code
Bob	220	1
Tracy	130	5
Felix	179	3
Mort	178	4
Natasha	115	6
Mario	185	2

The assigned values indicate only *rank* among measured cases, not actual weight differences among specific cases.

Interval Level of Measurement

The *interval level of measurement* is used when we assign numbers to variable values according to their position on some measuring scale consisting of a sequence of equidistant units of measurement. Such a scale is constructed so that the numerical interval between any two given numbers on the scale represents the same difference in the amount of the characteristic being measured no matter where that numerical interval occurs on the scale. In addition, the scale contains a zero point placed arbitrarily at some point on the scale so that the zero point itself and numbers above and below it all have a real value with respect to the characteristic being measured. An example of this level of measurement is measurement by calendar years, for example, 2 B.C., 1 B.C., Birth of Christ (zero point), 1 A.D., 2 A.D.,...1977 A.D. Notice that on this scale the numerical interval between the numbers 1145 A.D. and 1155 A.D. represents the same real value in terms of time as does the interval between the numbers 1945 A.D. and 1955 A.D., namely, 10 years. The same is true of 20 B.C. and 30 B.C. The interval in numbers still represents the same real 10-year value in time. This scale of numbers, however, is centered around an arbitrary zero point, the birth of Christ, and could easily be centered around any other event in history. The individual units of measurement are calendar years. This fact should be made clear in any explanation or definition of this variable.

Another example of the interval level of measurement might be measurement of temperature according to the Fahrenheit scale. The interval between the points 65°F and 68°F (namely, three units of measurement) represents the same real value in terms of temperature as does the interval between the points 14°F and 17°F. Again, there is a zero point that has a real value in terms of amount of heat, and numbers above and below it also have real values.

Ratio Level of Measurement

In the *ratio level of measurement*, as in the interval level, we assign numbers to variable values according to their position on some measuring scale consisting of a sequence of equidistant units of measurement. Again, the scale is designed so that the numerical interval between any two given numbers on the scale represents the same difference in the amount of the

characteristic being measured no matter where that numerical interval occurs on the scale. For the ratio level of measurement, however, there is an absolute zero point on the scale. This zero point indicates total absence of the characteristic being measured. For example, the variable "weight in pounds" can be measured according to the ratio level. The unit of measurement on this scale is the pound. "0" pounds means absolutely no weight. This is called the ratio level because the ratio between the numbers "24" and "12" on this scale

$$(\frac{24}{12} = \frac{2}{1})$$

would also indicate the ratio between the actual weights of the cases to which those numbers were assigned. Case A (24 lbs.) would actually be twice as heavy as Case B (12 lbs.). This would not be so with numbers assigned according to the interval level of measurement because there could be values above and below the zero point on the scale.

Numerical values assigned at the ratio level of measurement are often called "actual values." Any key for variables that you construct should indicate this.

On the next page you will find example variables. Try to determine what level of measurement to use in assigning numerical values for each variable.

EXERCISE 3

Write nominal, ordinal, interval, or ratio as the level of measurement.

Level of Measurement	Variable
_____	1. Height in feet
_____	2. Heat in degrees Celsius
_____	3. State of residence
_____	4. Altitude in feet according to sea level
_____	5. Fraternity
_____	6. Academic rank in class
_____	7. Height in inches
_____	8. Place of finish in a 2-mile race
_____	9. Sex
_____	10. Distance in meters

When you finish, turn to the next page.

FEEDBACK

1. Ratio
2. Interval
3. Nominal
4. Interval
5. Nominal
6. Ordinal
7. Ratio
8. Ordinal
9. Nominal
10. Ratio

If you missed any of these answers, think about them again.

MEASURABLE VARIABLES

Now that you are familiar with the four levels of measurement, you must be able to choose from among them a method for measuring the elements within a research hypothesis. For example, take the hypothesis, "If a family has a relatively high income and lives in the suburbs, then its house will be heated warmly for the winter." This hypothesis has three variables which we must be able to measure according to one of the levels of measurement. We could say that the variables are: 1) yearly family income, 2) place of residence, 3) thermostat setting. In each instance we can assign meaningful numerical values for the variable in each case we study. The cases are *families*. We will use the ratio level for measuring Variable #1, and the numbers assigned will indicate amounts of dollars the family makes in a year. We will measure Variable #2 with the nominal level, and the numbers will reflect a category of residence place, for example, urban, suburban, rural. For Variable #3 we can use the interval level, and the numbers will reflect the amount of Fahrenheit degrees (or Celsius degrees) at which the home is heated.

On the next page you will find a hypothesis. Define the variables and the levels of measurement you would use for each variable.

EXERCISE 4

Using the following hypothesis, name the variables you would investigate and at what level of measurement you would measure them.

If a person is male, has red hair, and is over 21, then he will be taller than most other people.

Cases are _____

Variable	Level (nominal, ordinal, interval, ratio)
1. _____	_____
2. _____	_____
3. _____	_____
4. _____	_____
5. _____	_____
6. _____	_____

When you finish, turn to the next page.

FEEDBACK

Each case is a person.

	Variable	Level
1.	Sex	Nominal
2.	Hair Color	Nominal
3.	Age	Ratio
4.	Height in Inches	Ratio

You may have called your variables something else, but be sure you have mastered the principles involved.

Finding measurable variables for all of the elements in some hypotheses can be rather challenging. Common sense, imagination, and a review of the literature are three good tools to assist you here. For instance, the quality of "intelligence" might be measured by using several variables, for example, I.Q. scores, SAT scores, class rank, grades, and so forth. You must determine whether the variables you choose to measure are valid in this respect.

Let us assume that you have measured the appropriate variables and wish to determine how they relate to one another statistically over a number of cases. This statistical analysis can be done by the computer in a fraction of the time it would take you to do it. However, the computer requires that you provide it with the measurements you have taken in a particular form and by a particular process. The rest of this package will be devoted to helping you put your information in the form that the computer requires.

SECTION 3

Data, Codebooks, and Missing Values

Upon completion of this section the learner will be able to

1. give a simple definition of *data*,
2. construct a codebook for a given questionnaire with
   a. variable names
   b. variable descriptions
   c. variable values
   d. missing value codes.

You are now ready to construct a codebook for a particular study. A codebook is simply information which accompanies a study to clarify and define the variables in that study, to assign coded values and interpretations of the value cards. We will deal with this last function in Section 4 of this package. For now we will be concerned with naming, describing, and interpreting the variables and the values of the variables in a given study for the purpose of readying your accumulated information for analysis by the computer.

DATA

Data are the information gathered by a researcher in the course of the examination of a phenomenon or the relationships between two or more phenomena. This information should represent the result of a systematic, controlled, empirical, and critical investigation. Usually, it consists of values for variables on a number of different cases.

Let us go over that again. *Data are the information gathered by a researcher in the course of his or her examination of a phenomenon or the relationships between two or more phenomena, usually consisting of values for variables on a number of different cases.*

Data can take many forms and can be collected in many ways. In the social sciences one vehicle often used to accumulate data is the questionnaire. The questionnaire is distributed to a group of people (cases), and each question within it usually represents a variable since each question may be answered in a different way by different people. In this situation the answers to the questions in the questionnaire are variable values and each questionnaire filled out by a different person represents the data for a separate case. For the rest of this package we will deal exclusively with data accumulated by the questionnaire method although the treatment of variables in preparing for computer analysis is essentially the same no matter how the variable values are collected.

CODEBOOK CONSTRUCTION

Variable Names

For convenience in dealing with the statistical analysis of variables and for ease in identifying them, it is prudent to provide each question (or variable) with a name by which it can be identified throughout your study. For most computer programs such a name must

1) be as short and concise as possible,
2) start with a letter,
3) not contain more than eight characters,
4) have no spaces, blanks, or dashes imbedded in the name.

For example, a question asking, "What is your political party affiliation?" might be given the name "PARTYID." The question, "How much money do you make in the

course of a year?" might be assigned the name "INCOME." For many questions, especially basic classification data, the variable names can be almost self-defining. For example, for the question, "What was your age at your last birthday?", the name might be simply "AGE." If a particular variable does not lend itself to a concise name or abbreviation, it could be named "VAR1" or "VAR2" since you will define it more precisely later in the codebook. The important thing is to assign a name that makes it easy for you to identify the variable later in your analysis. The codebook in which you will record these names is a mechanism to help you remember, especially in the case of more complicated variables (questions). It will also be useful to other researchers unfamiliar with your naming procedure and your questionnaire who might want to use your data or your analyses.

On the next page you will find an exercise designed to give you practice in naming variables.

EXERCISE 5

For each of the following questions which were excerpted from a questionnaire, construct a variable name. When you are through, turn the page.

QUESTIONNAIRE
(Sample of Questions)

I.D. NO._____

Please answer the following questions to the best of your ability. Mark your answers clearly and legibly. Please report only *one* answer for each question.

11. How tall are you in inches? .....

12. How many times have you visited a physician in the past year? .....

13. How many children do you have? .....

14. What is your religion?

Protestant	.....
Catholic	.....
Jewish	.....
Other	.....
No Religion	.....

15. How many times a week do you go to the grocery store?

1 time	.....
2 to 4 times	.....
More than 4 times	.....
Not at all	.....

Thank you for your cooperation!

Question 11	Variable Name _____
Question 12	Variable Name _____
Question 13	Variable Name _____
Question 14	Variable Name _____
Question 15	Variable Name _____

FEEDBACK

There are no right answers to this exercise, but here are some possible alternatives.

11. HEIGHT
12. MDVISITS
13. KIDS
14. REL
15. GROTRIPS or VAR1

Once variable names have been assigned, they are placed in the codebook. The following is an example of the way the codebook might look once this is done.

NOTE that there are other column headings in the codebook. These will be explained later. You need only be concerned with the "Variable Name" column now.

CODEBOOK

Field	Variable Names	Variable Descriptions	Values
	HEIGHT		
	MDVISITS		
	KIDS		
	REL		
	GROTRIPS		

Variable Descriptions

The next procedure in the codebook is to provide a description for each variable name in your study. This description should clearly define the variable name so that someone unfamiliar with your study can find out everything he needs to know about each variable in order to utilize your data in a study of his own. Complete sentences are not necessary, but you need to give all the qualifying information for each variable. After placing variable descriptions in the codebook, the codebook might look like this for the sample questions we gave earlier.

CODEBOOK

Field	Variable Names	Variable Descriptions	Values
	HEIGHT	Respondent's height in inches	
	MDVISITS	Number of visits to physician in past year	
	KIDS	Number of children of respondent	
	REL	Respondent's religious preference	
	GROTRIPS	Number of visits per week to grocery store	

Values

The next step is to describe the possible values for each of your variables. This should be written as an addendum to each variable description and should explain exactly what the values you are assigning to each variable mean. For example, if your variable/question is, "What is your political affiliation?", and in the questionnaire you provide the possible choices--Democrat, Republican, Libertarian, American, Independent, Other--you might assign the nominal values for the variable as (1) for Democrat, (2) for Republican, (3) for Libertarian, (4) for American, (5) for Independent, and (6) for Other. If this were the situation, and you entered these values in a codebook, it might look like the table on the following page for that one variable.

CODEBOOK

Field	Variable Names	Variable Descriptions	Values
	PARTYID	Respondent's political party identification	(1) Democrat (2) Republican (3) Libertarian (4) American (5) Independent (6) Other

This information lets anyone looking at the codebook know exactly what these values mean when they appear for this variable in your data. For a variable/question such as income, the respondent simply fills in the correct numbers to answer the question, such as 11,500. If we have 500 respondents, we might have 500 possible values for income. We do *not* want to include each value in our codebook since we know the exact meaning of each--the yearly income of the respondent. Therefore, for variables measured at the interval or ratio scale of measurement, our codebook could look like this:

CODEBOOK

Field	Variable Names	Variable Descriptions	Values
	INCOME	Income for the past 12 months	Exact income

Missing Value Codes

Let us assume that for some of the questions on a given questionnaire, in one or more cases, the respondent(s) failed to answer. If the computer is not made aware of this fact, it cannot provide the proper analysis of the data collected for that variable. For instance, if you want the computer to compute the average age of four respondents in a study, and one of the respondents has failed to fill in the question concerning age, the computer will still tally the total ages it finds in your data and divide by four. Obviously, if one of the ages is missing, the result will be misleading. Let us say the ages are for Case #1--26, for Case #2--35, for Case #3--no age, for Case #4--38. The computer totals the ages (26 + 35 + 38) and divides by 4 to get the average, 24.75 years. No matter what the age of the respondent in Case #3, the average is wrong.

Consequently, for each variable value that is missing in one or more cases, a *missing value code* must be assigned and recorded in the codebook. This missing value code must be used in every case in which that variable is missing once you actually begin to record your data. Certain statistical computer programs that you may use will alert the computer that for a particular case the variable value is missing, and the computer will drop that case from any statistical analysis of the variable involved. *You* must find out how the computer program that you plan to use handles missing values.

The missing value code should be of a nature that insures that it will not be read as a legitimate value for the variable involved. In other words, the value code chosen must be outside the range of legitimate values for the variable. For example, if your study deals with young adults, you might use the code "0" as the missing value code for the "AGE" variable, or you could use the code "99." As a missing value code for an "INCOME" variable that uses exact values, "99999" might be good if you are sure that no one in the study made that kind of money, or "0" might be a good missing value code if you are sure that no one in the study reported zero income. You might want to

leave the columns on the computer card blank if the value is missing. However, you must be careful about this since blanks may be read as zeroes. Again, check the manual of the computer program that you plan to use to see how the program handles missing values.

Once you have determined a good missing value code, you need to record that code in the codebook. This can be written directly under the values column next to the variable to which it applies.

For example:

CODEBOOK

Field	Variable Names	Variable Descriptions	Values
	PARTYID	Respondent's political party affiliation	(1) Democrat (2) Republican (3) Libertarian (4) American (5) Independent (6) Other (9) Missing
	INCOME	Income for past 12 months	Exact income (99999) Missing

The exercise on the following page gives you the opportunity to develop your own codebook using the questionnaire on page 17. Fill it out with variable names, descriptions, values and missing value codes for a set of variables.

EXERCISE 6

Create a codebook for the questions on page 17 of this section by filling out the columns below. Disregard the "Field" column, which will be discussed in Section 4.

CODEBOOK

Field	Variable Names	Variable Descriptions	Values

When you are finished, turn to the next page for some feedback.

FEEDBACK

Here is the way we would have filled out the codebook for the five variables listed. If your answers are not like this, that does not make them wrong! However, they should be in the same format and include all of the same elements.

CODEBOOK

Field	Variable Names	Variable Descriptions	Values
	HEIGHT	Respondent's height in inches	Exact height (9) Missing
	MDVISITS	Number of visits to physicians in past year	Exact number (99) Missing
	KIDS	Number of children of respondent	Exact values (99) Missing
	REL	Respondent's religious preference	(1) Protestant (2) Catholic (3) Jewish (4) Other (9) Missing
	GROTRIPS	Number of visits per week to grocery store	(1) 1 time (2) 2-4 visits (3) More than 4 visits (4) Not at all (9) Missing

If you feel you have mastered the codebook up to this point, go on to the next section. If not, review those portions that are not clear to you before continuing.

SECTION 4

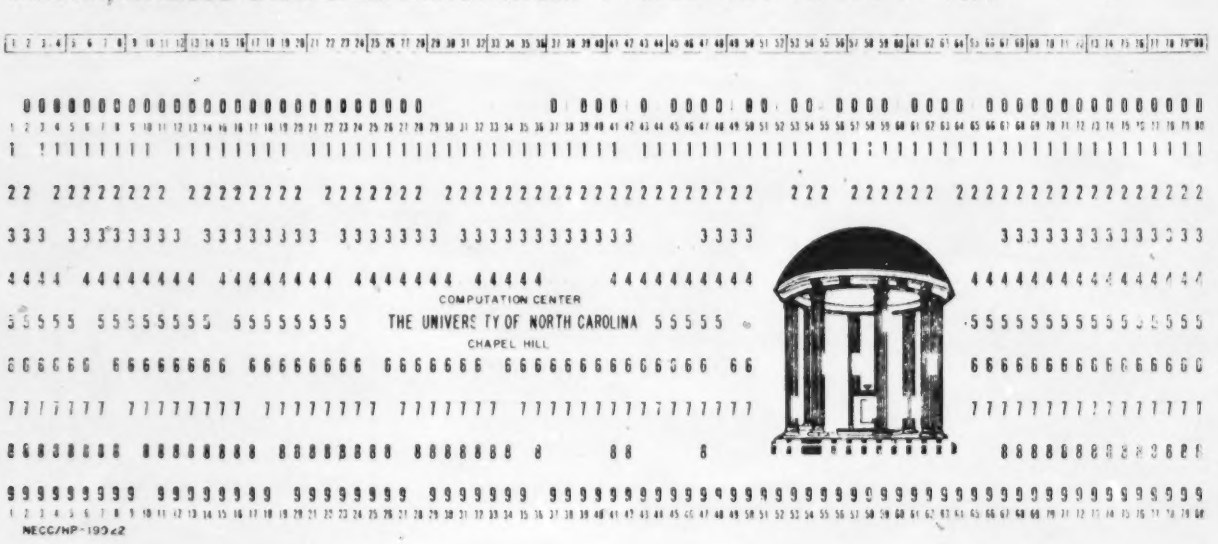
Computer Cards, Fields, and Coding Sheets

Upon completion of this section the learner will be able to

1. discuss the concept of punching information on the computer card,
2. define field and state how many fields exist on computer cards,
3. assign fields to specific variables from a given questionnaire,
4. discuss the relationship between the coding sheet and the computer card, and
5. fill in the coding sheet for questionnaire samples given.

Now we have to find a way to get the data into a form that can be used by the computer for analysis. One common communication medium used to give data and instructions to the computer is the keypunched computer card.[1] A computer card is essentially a thin rectangular card that allows for 80 columns of symbols. The concept underlying the use of this card is the translation of each of the alphabetical, numerical, and symbolic characters (letters, numbers, punctuation marks) you have used in coding your data into a specific, unique pattern of punched holes in a single column--one character--one column. You will find an actual computer card located in the back page of this manual.

Here is a sample of a computer card that contains all of the characters possible for use in computer language. These characters are written across the top of the computer card. Notice that in the column beneath each of these characters is a unique pattern of punched holes. No two columns are the same. Sometimes one, sometimes two, sometimes three holes appear in a column in unique patterns.



1. These cards are available at no cost for use at either your computation center or IRSS at UNC-CH.

It is by feeling these holes that the computer is able to read the information you give it. Think of the computer as a blind person. It cannot see. You must translate the information you give it into a language it can feel. The process of preparing the computer cards that provide this translation is called *keypunching*.

In research we are often dealing with a given set of variables and how they occur in several or many different cases. In translating this information onto computer cards, *one card is used for each case*, and all of the variable values for that case are recorded on that card along with certain identification information. Sometimes, however, a study may have so many variables, or it may have variable values that consist of so many characters, that the 80 available columns on one computer card cannot contain all the data for one case. When this situation develops, a second card, or more if necessary, can be used immediately following the first as page 2 follows page 1.

The important thing to remember is that the position of specific variable values on the computer card or cards must be identical for all your cases. This type of positioning is called Fixed Variable Format, which is the only type of positioning we will discuss although other types exist. When using Fixed Variable Format, no matter what use you make of a particular column or set of columns on the computer card(s) for Case #1, whether it be an identification number, a variable value, or a space, that column or set of columns must be used for this same exact purpose for all of your cases. This holds true no matter how many cards you require for each case. For example, if Columns 5 and 6 on card 2 of Case #1 are used to record the values of the variable "AGE," then Columns 5 and 6 on card 2 of every other case in the study must record the variable "AGE" for each case.

The reason for this precision in positioning information on the computer cards is that only values for variables are coded on the cards; the variable names are not. Consequently, the only way the computer can determine which values correspond to which variable names is by knowing in exactly which columns to look for a specific variable's values for any given case in the study involved.

FIELD

A convenient term used with reference to the computer card and coding your data for the computer is "field." A field on a computer card is the total set of columns used to code any single variable. For instance, in the "AGE" example just cited, the assigned field would be Columns 5 and 6. This same field would contain within it the values for the variable "AGE" in all of the case cards of this particular study unless each case required more than one card to record all of its variable values. In this situation the values for the variable "AGE" would appear in the same field of the same card number for each case in the study.

When coding and keypunching your values in a given field, you must remember to use "right justification." This simply means that the value of any variable must be referenced to the furthest right position within its field. In the "AGE" example, for instance, if you are coding a value of 9, the numeral 9 must appear in the furthest column to the right in the field assigned for "AGE" values--Column 6. If it were placed in Column 5, the computer would read the blank in Column 6 as a 0 and would read the value itself as 90. Similarly, if you had a value of 55 for a variable "WEIGHT" with an assigned field of Columns 8-10, you would code 55 in Columns 9 and 10 and leave Column 8 blank.

In the interest of observing the principle of field consistency and for efficient organization, it is prudent to assign a specific field for recording each item before actually keypunching your coded values onto the computer cards. This can be done as an extension of the codebook you have already learned to prepare. When determining the width of the field for a variable, you must determine the largest value (in column width) that will occur for that variable and use this information to assign the specific field for the variable. For example, if you want to specify the field width for the variable "AGE," and someone in your sample is 100, then you must use 3 columns--for instance, Columns 5, 6, and 7--to record the age in each case and remember to right justify.

Now you know the purpose of the "Field" column in the codebook: to assign a field for the recording of the values for each variable. On the next page is an exercise to help you practice this.

EXERCISE 7

Answer the following questions:

1. What is a field?

2. When do you use more than one computer card for recording the data from one case?

3. How does Card 1 of Case #5 relate to Card 1 of Case #10 in the same study in terms of field use when using Fixed Variable Format?

When you have finished, turn to the next page.

FEEDBACK

1. A field is the set of columns used for recording a variable's values on a computer card.

2. When there is not enough room on one card for all the variable values to be recorded for each case, more than one computer card will be required. This occurs when you need more than 80 columns to record all the values.

3. Field use for each card is exactly the same.

If you missed any of the above answers, go back and review this material before continuing on.

FIELD ASSIGNMENT

Let us get on with assigning fields. If you can, keep a mental image of the 80 column computer card in your mind while we do this. If you want to, use the sample computer card for reference.

The first information you will want on the computer card is the case number of the data you are recording on a particular card. This can take up Column 1 if there are between 1 and 9 cases in your entire study. If there are from 10 to 99 cases, you will need to assign two columns, one for each character (numeral in this case) in the I.D. number. If you have between 100 and 999 cases, you will need to assign three columns, and so forth.

If you have between 10 and 99 cases in your study, the proper entry of field assignments will look like this:

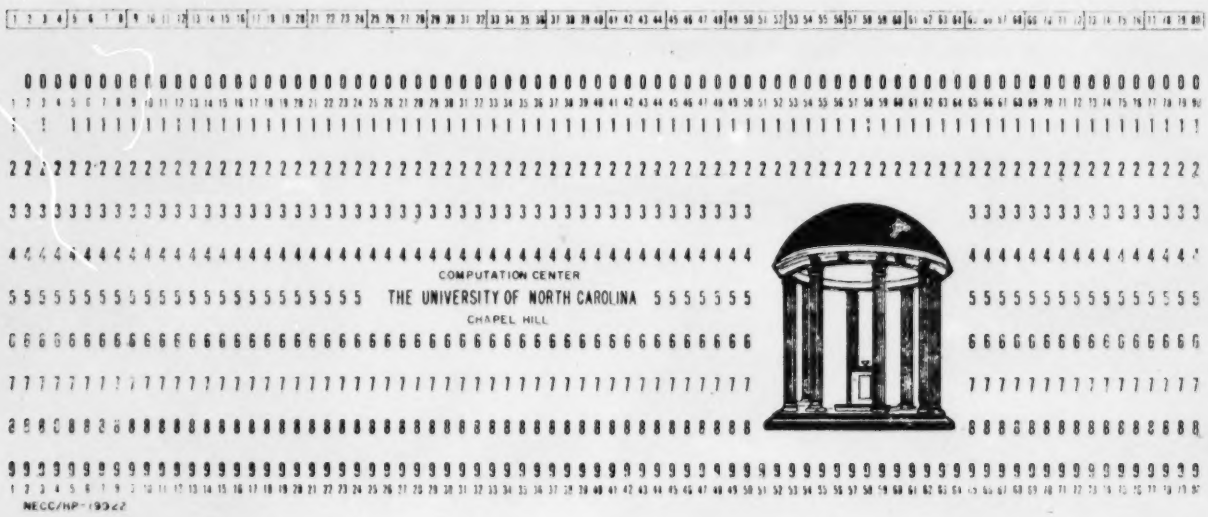
CODEBOOK

Field	Variable Name	Variable Descriptions	Values
1 - 2	CASEID	Case identification number	

As mentioned previously, if you have many variables in your study and/or if some of your variables have values requiring four or five or more columns (like income), you may not be able to enter all variable values for one case within one computer card's 80 columns. When this happens, you can use a second card with the same Case I.D. number, of course.

In order to be sure that the computer recognizes that there are two cards per case, you need to assign *card identification numbers*. Your Case I.D. number might be recorded in Columns 1 and 2; you then leave a column empty as a space and use Column 4 for the Card-I.D. number. It would look like this on Card #1 for Case #1:

01 1



NOTE: It is acceptable, but *not* necessary, to leave one or more columns empty between values or I.D. numbers as spaces for ease in reading the card. These spaces must be in exactly the same columns for all cases. (You do not need to record fields used as spaces in the codebook). In the interest of economy, we normally use *all* of the columns for variable values since the computer does *not* need blank columns between fields. We will leave blank columns between fields in our examples so that you can read the cards easily.

It would look like this in your codebook:

CODEBOOK

Field	Variable Name	Variable Descriptions	Values
1 - 2	CASEID	Case identification number	
4	CARDID	Card identification number	

Once you have your Case I.D. number and Card I.D. number fields assigned, you are ready to begin assigning fields for variable values on the cards. These variable values must appear in exactly the same field (or columns) for each case in your study. Thus, if you have assigned in your codebook the field consisting of Columns 6 and 7 for the value of the variable "AGE," Column 9 for "SEX," and Columns 11, 12, 13, 14, and 15 for "INCOME," the specific values of these variables must appear in these same exact fields on each case's card(s). Thus Card #1 for

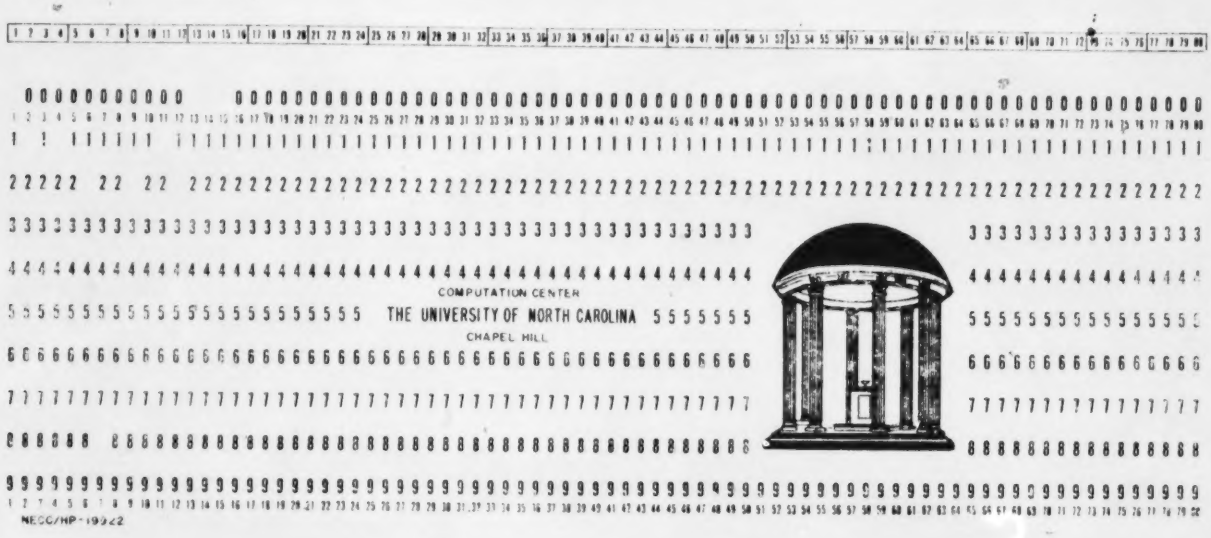
CASE 1
CARD 1

01 1 28 2 12000

Case #1 and Case #8 in the same study might look like this if the following were the appropriate coded values:

Case #1 ... AGE - 28 (exact value)
SEX - male (assigned nominal value 2)
INCOME - 12000 (exact value)

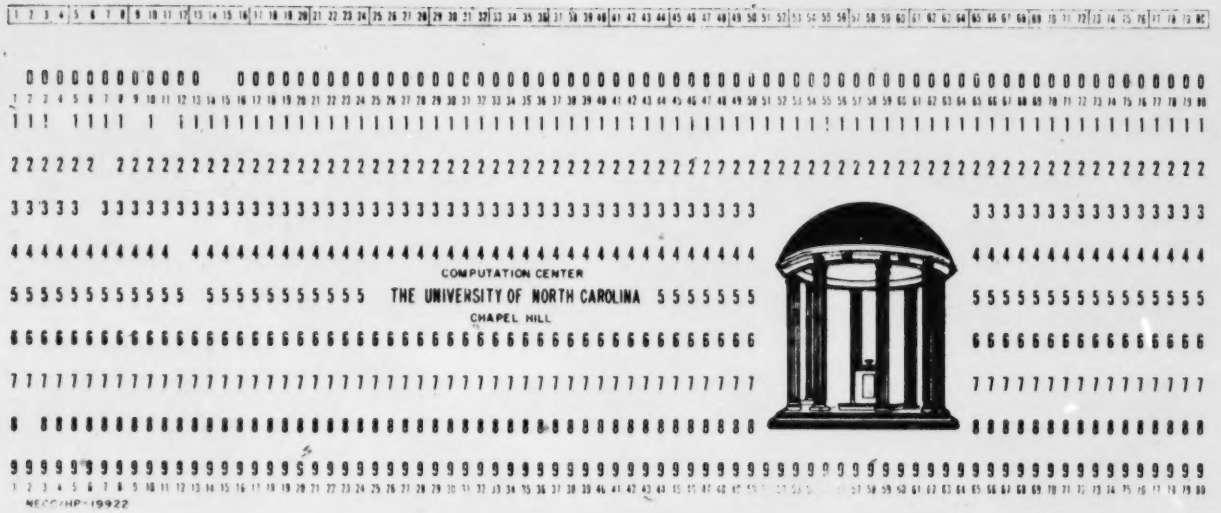
Case #8 ... AGE - 32 (exact value)
SEX - female (assigned nominal value 1)
INCOME - 14500 (exact value)



30

CASE 8
CARD 1

68 1 32 1 14500



You are now ready to practice what you have just learned. Turn to the next page.

EXERCISE 8

Try to complete the codebook for our sample study questions. Turn back to our sample codebook on page 23 of this package and fill in the "Variable Names" and "Variable Descriptions" information for Case and Card identification numbers, assuming the study consisted of 450 cases. Do this in the blank area above the information on the HEIGHT variable. Then, under "Field," assign appropriate column numbers for each variable and I.D. number. When you are through, turn to the next page for some feedback.

FEEDBACK

Compare your answers for Field assignment with the following:

CODEBOOK

Field	Variable Names	Variable Descriptions	Values
1-3 (Total number of cases is 450, three digits)	CASEID	Case identification number	
5 (only five total variables, need only one card per case)	CARDID[2]	Card identification number	
7-8 (two digit values)	HEIGHT	Respondent's height in inches	Exact value (9) Missing
10-11 (probably no three digit responses to this question)	MDVISITS	Number of visits to physician in past year	Exact value (99) Missing
13-14 (could be two digit responses, plus missing value is two digit)	KIDS	Number of children of respondent	Exact value (99) Missing
16 (one digit nominal values)	REL	Respondent's religious preference	(1) Protestant (2) Catholic (3) Jewish (4) Other (9) Missing
18 (one digit nominal values)	GROTRIPS	Number of visits per week to grocery store	(1) 1 time (2) 2-4 visits (3) More than 4 visits (4) Not at all (9) Missing

2. You really only need CARDID numbers when you have more than one card per case. Then, if you should drop your data deck, you will be able to place the cards in their proper order. We have included a CARDID variable here as an example for you.

If you have filled out the codebook correctly, continue on. If not, review this section and continue after you understand your errors.

PREPARATION OF CODING SHEET

You are now ready to fill out a coding sheet for each computer card that you will keypunch for your study. The Fortran coding sheet is a simple, graphic way of getting straight in your mind what specific variable values and I.D. number are assigned to each of the 80 fields on a particular computer card in your study.

There is a Fortran coding sheet attached to the back of this package.[3] Detach it and look at it now. As you can see, there are 80 numbered columns on the sheet. These represent the 80 columns on a computer card. Down the left side of the sheet there are numbers 1-33. These numbers indicate the sequence of the cards in your study. Each number represents a different card. What we have on the sheet is a small block assigned to each of the 80 columns on 33 different cards. Before you actually do your keypunching, it is usually helpful to write the values for your variables and I.D. numbers in the appropriate blocks on the coding sheet, one row of blocks on the sheet for every card you will use. If you were filling out a coding sheet for the study whose codebook is on page 32, and the variable values for Case #1 of that study were:

HEIGHT = 72 inches
MDVISITS = 11 visits
KIDS = 2
REL = Jewish
GROTRIPS = 5 trips per month

the coding sheet would look like this:

FORTRAN CODING FORM NAME DEPARTMENT

CARDS TAPE

C FOR COMMENT
STATEMENT NUMBER | CONT.

	1	2 3 4 5	6	7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
1	0	0 1	1	7 2 1 1 2 3 3
2				

This would be followed in Row #2 by the number and values for either Case 1, Card 2 (if it was necessary to use two cards or more for containing the case's variable values) or for Case 2, Card 1. Remember, it is not necessary to leave blank columns between the variable fields for your study. It simply makes it easier for you to read when you are learning the procedure. On the following page is an exercise for you to complete.

3. If you wish to purchase additional coding sheets, they are available in the Student Stores.

EXERCISE 9

Turn to the codebook on page 32 and prepare a coding sheet for the first five cases of our sample study using the following data matrix. Use the sample Fortran coding sheet that is attached to this package to record your answers. Turn to the next page when you are finished for some feedback.

	HEIGHT	MDVISITS	KIDS	REL	GROTRIPS
Case 1	72	4	3	1	2
Case 2	65	3	1	1	1
Case 3	71	4	2	2	2
Case 4	75	2	10	3	3
Case 5	67	0	2		2

FEEDBACK

If your coding sheet looks like this, it is correct. If not, review Section 4 beginning on page 24. Use row 10 on the coding sheet as a starting point (pretend that it is row 1), and try the exercise again.

FORTRAN CODING FORM NAME DEPARTMENT

CARDS TAPE

C FOR COMMENT

STATEMENT NUMBER | Cont.

	1	2 3 4 5	6	7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37
1		001	1	72 4 3 1 2
2		002	1	65 3 1 1 1
3		003	1	71 4 2 2 2
4		004	1	75 2 10 3 3
5		005	1	67 0 2 9 2 (missing value from our codebook, p 23)
6				
7				
8				

KEYPUNCH OPERATION

Now you are ready to learn to operate the keypunch itself, to prepare the data cards for your study.

Locate an appropriate handout on your campus that will tell you how to operate a keypunch. Keypunch handouts are available at the User's Service desk at the Institute for Research in Social Science in the basement of Manning Hall at the University of North Carolina at Chapel Hill. You will find keypunch machines at the Computation Center (Phillips Hall, UNC-CH) and also in certain dormitories and buildings on campus, such as Manning Hall (UNC-CH) where the Institute is located. After you have mastered the keypunch machine (it should only take a few minutes), you are ready to learn to use one of the available statistical computer programs on the campus such as SAS (Statistical Analysis System) or SPSS (Statistical Package for the Social Sciences). The person at the User's Service desk at IRSS will give you a schedule of free short courses offered by the Institute each semester in conjunction with the Computation Center. You will find a variety of courses offered to help you learn about computer usage and some introductory courses taught by IRSS staff that are specifically designed to acquaint you with your selected statistical packaged program. Manuals for these programs are available for *very* limited usage at the User's Service Desk at IRSS and the Computation Center. These manuals can be purchased or ordered through student stores. If you are not familiar with the program, we strongly recommend that you attend one of the free short course sessions before you make your final decision about the selection of your program and the purchase of the manual.

Good luck!

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